1. (Original) A method of indexing a database of documents, comprising:

providing a vocabulary of n terms;

indexing the database in the form of a non-negative n x m index matrix V, wherein:

m is equal to the number of documents in the database;

n is equal to the number of terms used to represent the database; and

the value of each element v_{ij} of index matrix V is a function of the number of occurrences of the ith vocabulary term in the jth document;

factoring out non-negative matrix factors T and D such that

$V \approx TD$; and

wherein T is an n x r term matrix, D is an r x m document matrix, and $r <$ $nm/(n+m)$.

2. (Original) The method of claim 1 further comprising deleting said index matrix V.

3. (Original) The method of claim 2 further comprising deleting said term matrix T.

4. (Original) The method of claim 1 wherein r is at least one order of magnitude smaller than n.

5. (Original)   The method of claim 1 wherein r is from two to three orders of magnitude smaller than n.

6. (Original)   The method of claim 1 wherein entries of said document matrix D falling below a predetermined threshold value t are set to zero.

7. (Original)   The method of claim 2 wherein r is at least one order of magnitude smaller than n.

8. (Original)   The method of claim 2 wherein r is from two to three orders of magnitude smaller than n.

9. (Original)   The method of claim 2 wherein entries of said document matrix D falling below a predetermined threshold value t are set to zero.

10. (Original)   The method of claim 3 wherein r is at least one order of magnitude smaller than n.

11. (Original)   The method of claim 3 wherein r is from two to three orders of magnitude smaller than n.

12. (Original)   The method of claim 3 wherein entries of said document matrix D falling below a predetermined threshold value t are set to zero.

13. (Currently Amended)   <u>A method of indexing a database of documents, comprising:</u>

<u>providing a vocabulary of n terms;</u>

<u>indexing the database in the form of a non-negative $n \times m$ index matrix V, wherein:</u>

<u>m is equal to the number of documents in the database;</u>

<u>n is equal to the number of terms used to represent the database; and</u>

<u>the value of each element v_{ij} of index matrix V is a function of the number of occurrences of the ith vocabulary term in the jth document;</u>

<u>factoring out non-negative matrix factors T and D such that</u>

<u>$V \approx TD$.</u> ~~The method of claim 1 wherein said factoring out of non-negative matrix factors~~ ~~T and D further comprises:~~

selecting a cost function and associated update rules from the group:

cost function $\quad F = \sum_{i=1}^{n} \sum_{j=1}^{m} \left[V_{ij} \log(TD)_{ij} - (TD)_{ij} \right] \quad$ associated with

update rules $\quad T_{ik} \leftarrow T_{ik} \sum_{j} \dfrac{V_{ij}}{(TD)_{ij}} D_{kj} \quad , \quad T_{ik} \leftarrow \dfrac{T_{ik}}{\sum_{l} T_{lk}} \quad , \text{ and } \quad D_{kj} \leftarrow D_{kj} \sum_{i} T_{ij} \dfrac{V_{ij}}{(TD)_{ij}} \quad ,$

cost function
$$F = \sum_{i=1}^{n} \sum_{j=1}^{m} \left[V_{ij} \log \frac{V_{ij}}{(TD)_{ij}} - (V_{ij}) + (TD)_{ij} \right]$$
associated with

update rules
$$D_{kj} \leftarrow D_{kj} \frac{\sum_{i} \frac{T_{ik} V_{ij}}{(TD)_{ij}}}{\sum_{l} T_{lk}} \quad \text{and} \quad T_{ik} \leftarrow T_{ik} \frac{\sum_{j} \frac{D_{kj} V_{ij}}{(TD)_{ij}}}{\sum_{h} D_{kh}}$$
, and

cost function
$$\|V - TD\|^2 = \sum_{i=1}^{n} \sum_{j=1}^{m} (V_{ij} - (TD)_{ij})^2$$
associated with update rules

$$D_{kj} \leftarrow D_{kj} \frac{(T^T V)_{kj}}{(T^T TD)_{kj}} \quad \text{and} \quad T_{ik} \leftarrow T_{ik} \frac{(VD^T)_{ik}}{(TDD^T)_{ik}} \text{ ; and}$$

iteratively calculating said update rules so as to converge said cost

function toward a limit until the distance between V and TD is reduced to or beyond a

desired value.

14. (Original)   A program storage device readable by machine, tangibly

embodying a program of instructions executable by the machine to perform method steps

for indexing a database of documents, said method steps comprising:

providing a vocabulary of n terms;

indexing the database in the form of a non-negative n x m index matrix V,

wherein:

m is equal to the number of documents in the database;

n is equal to the number of terms used to represent the database; and

the value of each element v_{ij} of index matrix V is a function of the number

of occurrences of the ith vocabulary term in the jth document;

factoring out non-negative matrix factors T and D such that

$$V \approx TD;\text{ and}$$

wherein T is an n x r term matrix, D is an r x m document matrix, and $r <$ $nm/(n+m)$.

15. (Original)   A database index, comprising:

an r x m document matrix D, such that

$$V \approx TD$$

wherein T is an n x r term matrix;

V is a non-negative n x m index matrix , wherein each of its m columns represents an jth document having n entries containing the value of a function of the number of occurrences of a ith term appearing in said j^{th} document; and

wherein T and D are non-negative matrix factors of V and $r < nm/(n+m)$; and

wherein each of the m columns of said document matrix D corresponds to said j^{th} document.

16. (Original)   A method of information retrieval, comprising:

providing a query comprising a plurality of search terms;

providing a vocabulary of n terms;

performing a first pass retrieval through a first database representation and scoring m retrieved documents according to relevance to said query;

executing a second pass retrieval through a second database representation and scoring documents retrieved from said first pass retrieval so as to generate a final relevancy score for each document; and

wherein said second database representation comprises an r x m document matrix D, such that

$$V \approx TD$$

wherein T is an n x r term matrix;

V is a non-negative n x m index matrix , wherein each of its m columns represents an jth document having n entries containing the value of a function of the number of occurrences of a ith term of said vocabulary appearing in said j^{th} document; and

wherein T and D are non-negative matrix factors of V and $r < nm/(n+m)$; and

wherein each of the m columns of said document matrix D corresponds to said j^{th} document.

17. (Original)   The method of claim 16 wherein said final relevancy score for any j^{th} document is a function of said j^{th} document s corresponding entry in said document matrix D and the corresponding entries in said document matrix D of the Γ top-scoring documents from said first pass retrieval.

18. (Original)   The method of claim 17 wherein said relevancy score function for said j^{th} document is proportional to a sum of cosine distances between said j^{th} document s corresponding entry in said document matrix D and each of said

corresponding entries in said document matrix D of the Γ top- scoring documents from said first pass retrieval.

19. (Original)   The method of claim 16 wherein r is at least one order of magnitude smaller than n.

20. (Original)   The method of claim 16 wherein r is from two to three orders of magnitude smaller than n.

21. (Original)   The method of claim 16 wherein entries of said document matrix D falling below a predetermined threshold value t are set to zero.

22. (Original)   A program storage device readable by machine, tangibly embodying a program of instructions executable by the machine to perform method steps for information retrieval, said method steps comprising:

providing a query comprising a plurality of search terms;

providing a vocabulary of n terms;

performing a first pass retrieval through a first database representation and scoring m retrieved documents according to relevance to said query;

executing a second pass retrieval through a second database representation and scoring documents retrieved from said first pass retrieval so as to generate a final relevancy score for each document; and

wherein said second database representation comprises an r x m document matrix D, such that

$$V \approx TD$$

wherein T is an n x r term matrix;

V is a non-negative n x m index matrix , wherein each of its m columns represents an jth document having n entries containing the value of a function of the number of occurrences of a ith term of said vocabulary appearing in said j^{th} document; and

wherein T and D are non-negative matrix factors of V and $r < nm/(n+m)$; and

wherein each of the m columns of said document matrix D corresponds to said j^{th} document.